Forecasting geomagnetic secular variation based on magnetic diffusion at the core-mantle boundary

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The International Geomagnetic Reference Field (IGRF) is a standard mathematical description in terms of spherical harmonic coefficients, known as the Gauss coefficients, for the Earth's main magnetic field and its secular variation, updated every five years. In the next IGRF revision, the 13th generation of IGRF (IGRF-13), the Definitive Geomagnetic Reference Field for 2015 (DGRF-2015), the IGRF for 2020 (IGRF-2020), and the Secular Variation (SV) from 2020 to 2025 (SV-2020-2025) are to be released. We are planning to submit a model of SV-2020-2025 using our strong points, such as geodynamo numerical simulations, data assimilation, and core surface flow modeling.

Forecasts of geomagnetic SV are likely to require geomagnetic secular acceleration (SA), which can be expressed in terms of core fluid velocity and acceleration in the first time derivative of induction equation. In fact, Whaler and Beggan (2015) pointed out that forecasts of the Earth's main magnetic field and its temporal changes are improved for a model in which fluid velocity and acceleration are included. They also suggested that the quality of forecasts might be lowered for a period during which a geomagnetic jerk, a sudden temporal change in the geomagnetic acceleration, occurs. On the other hand, however, Fournier et al. (2015) pointed out that core flow acceleration could be neglected to forecast SV through data assimilation. Thus it is important to clarify the necessity of employing core flow acceleration.

In this presentation, we investigate whether or not geomagnetic SA is of importance to forecast geomagnetic SV, taking into account geomagnetic jerks occurred in 2003 and 2007 (e.g. Olsen and Mandea 2007; Chulliat et al. 2010). We assume that geomagnetic SV is caused only by magnetic diffusion at the core-mantle boundary, because core flow should vanish at the core surface on the no-slip boundary condition. We also show that the present method of forecasting the Earth's main magnetic field and its SV is consistent with simple analytical extrapolation of geomagnetic field. In other words, such simple extrapolation is based on a physical phenomenon of magnetic diffusion.

Keywords: IGRF, geomagnetic secular variation, magnetic diffusion

